Indian Institute of Science

Design of Photovoltaic Systems

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NPTEL Online Certification Course

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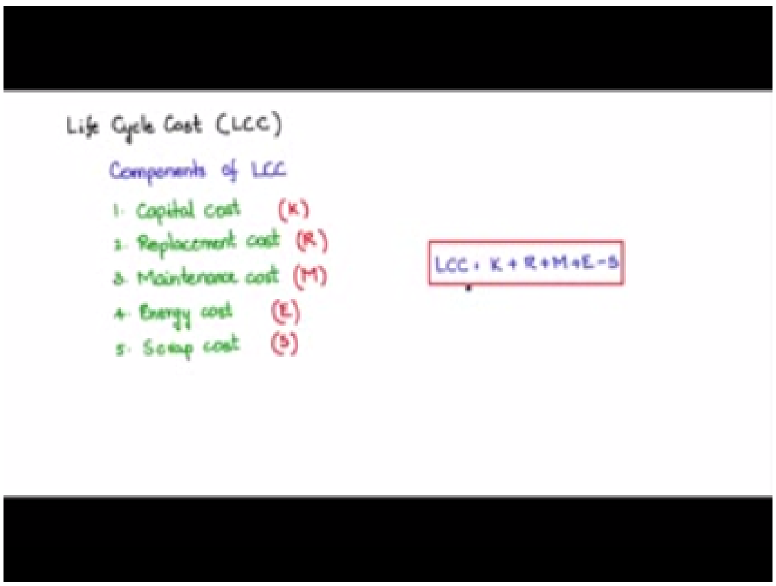

Let us now discuss about life cycle cost it is called LCC for short it is an acronym with an example we will also see how we will go about doing the lifecycle costing analysis what are the various components of lifecycle cost first we need to know about capital cost we need to know about a replacement cost so the capital cost is the initial investment that you would put at point zero times zero which is now today replacement cost or actually after some years down the line some of the subsystems which have lesser life than the overall lifespan of the system needs.

To be replaced so they will have to be reflected back to the present for comparison for adding and comparison then there is the maintenance cost you will have the end and you'll maintenance cost coming to the picture or meter the cost in general sometimes you will have energy cost and then the scrap value of the scrap cost scrap cost is actually the salvage value at the end of the life if there is any amount any cost any price that you can recover from it that is subtracted these are all investments from your side scrap cost is actually coming back to you whatever left.

Whatever is remaining so let us give some symbols capital cost will call K replacement cost as R maintenance cost as M energy cost as E and scrap cost as S energy costumes crap cause need not come always sometimes you will not have any scrap cost and sometimes you will not have energy cost in particular system it will be insignificant so but most of the time you will definitely have capital cost replacement cost and maintenance cost in most of the renewable energy type of systems.

Now LCC lifecycle cost is given by K capital cost + R replacement cost + M maintenance cost +E energy cost -scrap value so this is the lifecycle cost thing you will generally define a period of life so 15 years like those analysis for 15 years 20 years life of the system entire system perform a life cycle costing. So generally that is how it goes we will try to understand this by working out a simple example.

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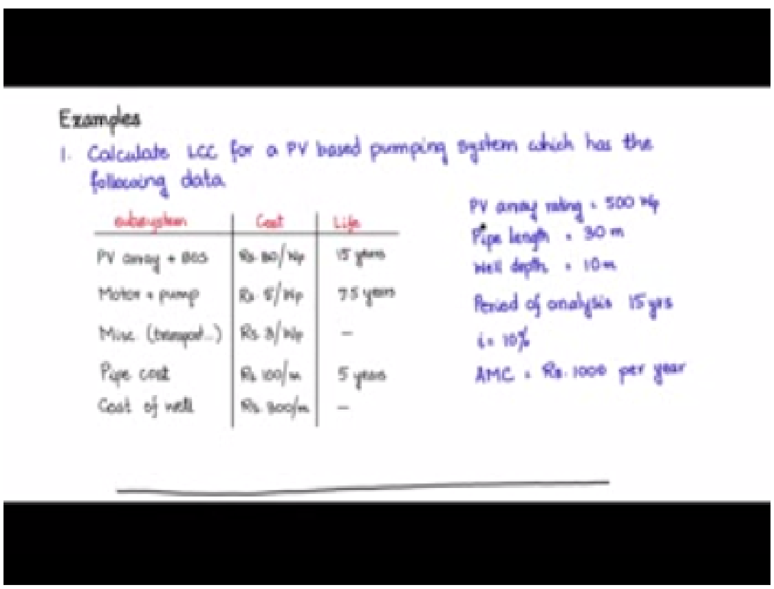

Let us consider an example calculate lifecycle cost for a PV based pumping system which has the following data now what is the data let me tabulate that so what are the subsystems I will list that down then in one column value cost and another column I will give life in years so in the PV based pumping subsystem one of the main items would be PV array plus balance of systems now I will put an approximate value rupees 80 per watt-peak is the cost for the PV array n balance of systems and the life is 15 years motor + pump motor pump set.

It is around approximately rupees five per Pequot 7.5 years miscellaneous for transport and such I will put rupees 3 rupees per D quite then piping costs rupees 100 or meter and the pipe have a life span of five years then cost of well the normal well rupees 300 per meter and then no life so I just put some representative costs probably at the point of at the time of calculating you will have to go to the market check and then put the actual costs to get a more realistic value anyway here we want to study the concept.

I will just put approximate values of the cost so this is the data that is available to you let us specify the system so PV array ratings is 500 watt peak the pipe length is 30 meters the well depth the depth width the well is dug out is 10 meters the period of interest the period for which the analysis has to be performed is 15 years means 15 years lifespan of the entire PV based pumping system let us take interest as 10% 10% is on the higher side but does not matter easy for calculation annual maintenance charges. There is a MC annual maintenance charges for the entire system is rupees thousand every year for the total 15 years lifespan of the system.

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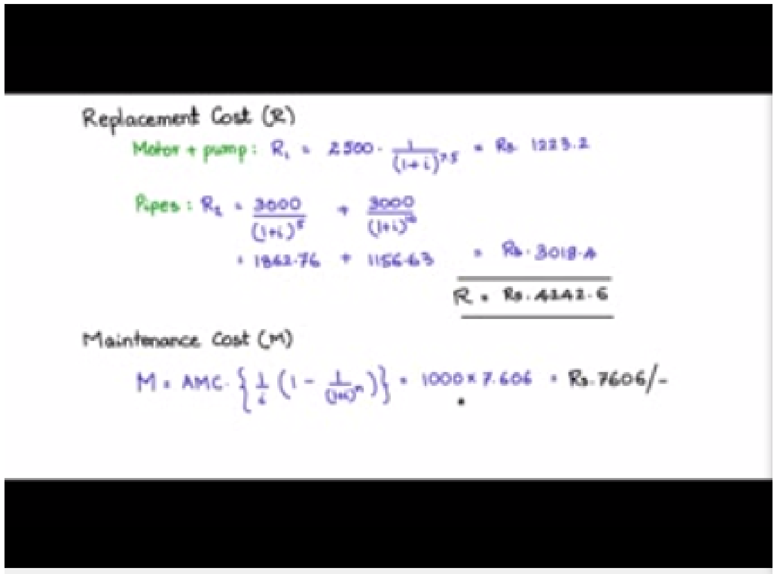

So now let me draw the time line to understand what this whole system is this is time zero and that is where all the capital investment is made now I am going to split the entire time line into three intervals five years five years ,five years so that you get a total of fifteen years entire life span so I will mark that five years ,five years ,five years all right at the center here seven 7.5 years from here you see that the life span of the mortar + pump is seven point five years which means at the end of seven point five years you have to make a preventative replacement.

For the system to function pipes five years at the end of every five years you are to make a replacement for the pipe so we will do that so let us know down at seven point five years we have to make one replacement for the motor plus pump then at the end of the first five year you have to make one replacement of the pipe set at the end of ten years second five years pipe replacement again and then you see the end of the life span so you do not need to make any further replacement so two pipe will clear replacements and one motor come set.

A replacement next I am marking tick marks for every year so now you have one two three four five so on up to year 15 now this is for the annual maintenance we have a DMC of thousand rupees that we need to give every year we need to give a thousand rupees here at the end of the third year fourth year fifth year so on the end of the fourteenth year and end of the fifteenth year so like that games he has to be given every year so this is geometric progression we know how to solve that we will do that at that point in time so now we need to calculate.

What is the capital cost what is the replacement cost and read what the aim she cause what we have written in agree so let us do that exercise so first let us calculate the capital cost K so R a cost rupees eighty per Pequot into 500watt peak he is rupees 40,000 then motor pump cost rupees five or Pequot into five hundred watt peak which is rupees 25,000 then we have the miscellaneous cause we had port rupees we had put rupees 3 per peak what let me S into 500 watt peak this is rupees thousand five hundred the pipe cost rupees 10 rupees 100 per meter into 30meters which is rupees three thousand then the cost of the well is rupees 300per meter into ten meter this is rupees three thousand.

So when you add up all these things you get K the capital cost which is rupees fifty thousand next let us calculate the replacement cost R we saw that we need to replace the motor pump set at the end of seven point five years one replacement in the entire lifespan or one I will call it two thousand five hundred this is the motor pump cost as there is no inflation we have not given an inflation value we should assume inflation rate F =0 so two thousand five hundred into 1 by 1 + I to the power of seven point five will be the present worth.

So whatever 2500 rupees you are going to put at 7.50 here present words bring it reflected to the present and you will get rupees 1 2 to 3 point 2 then pipes replacement we need to replacement one at the fifth-year and other than the tenth year so we know that the pipe cost is 3000 rupees so let us 3000 one + I to the power of five so the fifth year replacement reflected back present word will be 3000 by this month +3000 by 1 + I to the power of ten so the tenth year present work reflected back to the present is this value you add both of them 186 two point 76+ 1, 156 point 6,3 comes to please 3000 nineteen point four.

So when you add all the replacements you will get R is equal to rupees 424 2 .6 so next we will calculate the maintenance cost yeah so maintenance we saw that the annual maintenance we are paying 1000 rupees every year it is like the equal installments payment every year so M is equal to AMC into 1 by I 1 - 1 by1 + I to the power of yen which is the present worth factor so which is 1000 into present worth factor if you substitute for 0.1 you will get 7.6 and yen as fifteen so sorry in installments will give you distributed over fifteen years will give you rupees 7606.

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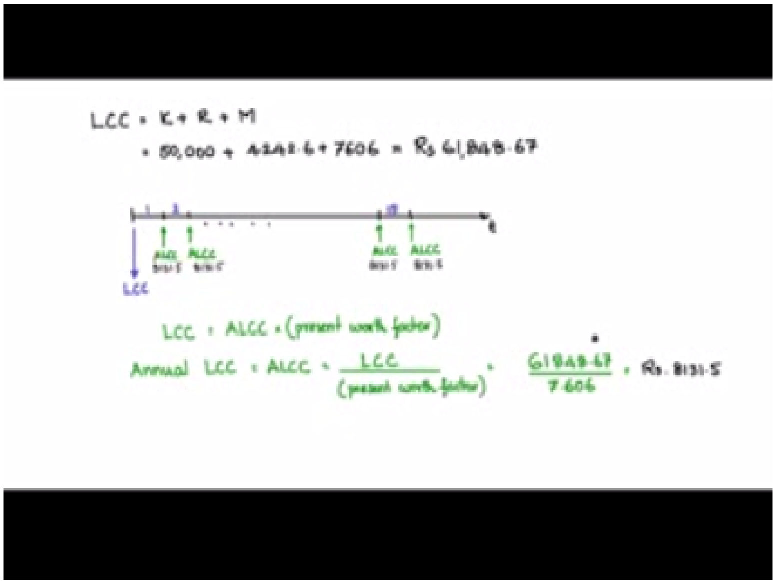

Next LCC which is K + R +M capital cost+ replacement cost +maintenance cost. Which is 50,000 + 4242.6 +7606 which will turn out to be rupees 61,848 .67 rupees so this is the life cycle cost total life cycle cost taking fifteen years life span now it will be interesting for us to distribute it over the entire 15 years in an annual way what is the equated annual installment that someone would pay for a present worth value of this so let us use the timeline T now at time 0 then year one year two soon E two so on two 15 year 15 that is our lifespan now at that time zero we have the LCC value of 60 1848 0.67 rupees that is the work of the entire system.

As of now as of today and he is the lifecycle cost taking into account all replacement maintenance everything has been reflected back into the present now this value can we distribute it as equated yearly annual installments for the next 15 years that will give you what is supposed to have been the payment annual payment equal annual payments for this particular system which could give us a reference or a benchmark so we would like to have a LCC annual LCC value so which is at the end of every year annual LCC value something like equivalent annual payments for this particular system in operation.

So this we know how to do LCC is equal to the present worth is equal to annual equal cause there is a geometric progression into the present worth factor and we know the present work factor how to calculate therefore LCC the annual LCC is equal to LCC which is equal to LCC divided by present worth factor and LCC is 61848.67 divided by 7.606 which will give you rupees 8131.5 so this is the annual LCC what it basically means that this value of 618 for a total system cost has a today all reflected to the present timeframe is equal to saying.

That every year for the next 15 years I pay eight one three 1.5 every 831.5, 831.5 till the end of the fifteenth year this is equal to saying that there is a equated annual installments for a fifteen year period. So this would give a nice benchmark for comparing other similar systems.

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I have here a small script file I will share this with you for working out example one that we just discussed calculate the LCC for a PV based pumping system having the following data so we discussed I have just classified the script file into subsystem data part where I have listed down the data the cost of the PV + array of the pump the life of the PV array and all those data which we just tabulated then I have the system specification which states the array rating of 500 Watts pipe length well depth the number of years of interest and the interest rate of interest AM see all these things are specified and then.

I have the life cycle costing calculations first you calculate the K which is the capital cost so calculated here the array cost the motor pump cost miscellaneous cause pipe cost to the well cost and then you add up all these costs to obtain the capital K then you calculate the replacement cost recall that we had one motor pumps replacement at the end of seven point five years and we needed to replace the pipes once at first at the end of five years and other at the end of ten years that is calculated the present worth you had up the motor pumps at replacement cost and the pipe replacement cost of present worth of both of them and obtained are the total replacement cost then you calculate young the maintenance calculate.

The present worth factor and calculate the maintenance present worth which is a MC the annual charges that you are being every year into the present worth factor and then finally calculate LCCC K +R + M and distributed equally over all the fifteen years to get ENC see Daniel and CC then I have the display part display the various cap so this will perform the calculations for that example and give you the results here I can I have octave Enron and opened run the example I x0 what I have stored it as ax 0 1 . Yeah I can run that and share this script file with you.

So after you run the calculations are displayed and after that all these values which we had calculated is what will be displayed and then you can take conclusions on that I will leave it to you to try out for different system data and different system specifications along these lines you can modify this script file to suit your needs.